

NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY

DEPARTMENT OF APPLIED CHEMISTRY

END OF SECOND SEMESTER EXAMINATIONS - MAY 2001

UNIT OPERATIONS - SCH 2208

TIME - (3) HOURS

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INSTRUCTIONS TO CANDIDATES

Section A and B are Compulsory. Answer **ANY TWO** questions from Section C.

SECTION A

1. Show why it is impossible to separate a liquid binary mixture by distillation when the volatility is one. (4 marks)
2. Discuss the Murphree Tray Efficiency Em. (8 marks)
3. Discuss the mode of operation of a freeze dryer and state the advantages and disadvantages of freeze drying as a method of drying. (10 marks)
4. A slurry of flaked soya beans weighing a total of 100kg contains 75kg of inert solids and 25kg of solution with 10wt% oil and 90wt% solvent hexane. This slurry is contacted with 100kg of pure hexane in a single stage so that the value of N for the outlet underflow is 1.5kg insoluble solid/kg solution retained. Calculate the amounts and compositions of the overflow V_1 and the underflow L_1 leaving the stage. (12 marks)
5. Briefly discuss tower packings in absorptions processes. (6 marks)

SECTION B

6. Fresh halibut livers containing 25.7wt% oil are to be extracted with pure ethyl ether to remove 95% of the oil in a counter current multistage leaching process. The feed rate is 1 000kg of fresh livers per hour. The final exit overflow solution is to contain 70wt% oil. The retention of solution by the inert solids (oil free liver) of the liver varies as follows, where N is kg inert solid/kg solution retained and y_A is kg oil/kg solution.

N	y_A
4.88	0
3.50	0.2
2.47	0.4
1.67	0.6
1.39	0.81

Calculate the amounts and compositions of the exit streams and the total number of theoretical stages. (20 marks)

SECTION C

7. (a) In a process for concentrating 1 000kg of freshly extracted orange juice containing 12.5wt% solids, the juice is strained, yielding 800kg of strained juice and 200kg of pulpy juice. The strained is concentrated in a vacuum evaporator to give an evaporated juice of 58% solids. The 200kg of pulp juice is by-passed around the flavour. This final concentrated juice contains 42wt% solids. Calculate the concentration of solids in the strained juice, the kg of final concentrated juice and the concentration of solids in the pulpy juice by-pass. (15 marks)
- (b) State *four* basic steps in solving a material balance problem. (5 marks)
8. (a) Sketch the diagram of a double effect evaporator system and derive material and energy balance equations on the system. (10 marks)

8. (b) A feed of 4 535kg/h of a 2.0wt% salt solution at 311K enters continuously in a single effect evaporator and is being concentrated to 3.0%. The evaporation is at atmospheric pressure and the area of the evaporator is 69.7m². Saturated steam at 383.3K is supplied for heating. Since the solution is dilute, it can be assumed to have the same boiling point as water. The heat capacity of the feed can be taken as $C_p = 4.10\text{kJ/kgK}$. Calculate the amounts of vapour and liquid product and the overall heat transfer coefficient U.

$$\lambda = 2\,230\text{kJ/kg}$$

$$H_v = 2\,257\text{kJ/kg}$$

(10 marks)

9. A rectification column is fed 100kgmol/h of a mixture of 50mol% benzene and 50mol% toluene at 101.32kPa pressure. The feed is liquid at the boiling point. The distillate is to contain 90mol% benzene and the bottoms 10mol% benzene. The reflux ratio is 4.52:1. Calculate the kgmol/h distillate, kgmol/h bottoms, and the number of theoretical trays needed.

If the overall tray efficiency is 70%, evaluate the actual number of trays.

The equilibrium data is as follows, where x and y are mole fractions of benzene.

x	0	0.130	0.258	0.411	0.581	0.780	1.000
y	0	0.261	0.456	0.632	0.777	0.900	1.000

(20 marks)

END OF QUESTION PAPER!!!